

WHAT IS CLAIMED AS THE INVENTION IS:

1. An actuator comprising:

an active region having at least one electroactive polymer layer, each polymer
5 layer having anisotropic mechanical properties responsive to an electrical change, and
at least two conducting layers arranged wherein a conducting layer is on each side of
each polymer layer;

a pair of mechanical connectors at either end of the active region;

a positive connector operably connected to the active region; and

10 a negative connector operably connected to the active region.

2. An actuator as claimed in claim 1 further including a means for monitoring strain
feedback for the active region whereby the actuator acts as a transducer.

15 3. An actuator as claimed in claim 2 where the electroactive polymer layer is
prestretched during fabrication.

4. An actuator as claimed in claim 3 wherein the electroactive polymer layer is one
of a single polymer, a copolymer and a composite.

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5. An actuator as claimed in claim 3 wherein the electroactive polymer layer has a
circumferential direction and an original length and the prestretch of the polymer
layer in the circumferential direction is between 50% and 600% of its original

length in the circumferential direction.

6. An actuator as claimed in claim 5 wherein the electroactive polymer layer has an axial direction and an original length and the prestretch of the polymer layer in the axial direction is between 0% and 150% of its original length in the circumferential direction.

7. An actuator as claimed in claim 3 wherein the thickness of the electroactive polymer layer is between 0.1um-1mm.

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8. An actuator as claimed in claim 3 wherein the electroactive polymer layer includes a plurality of adjacent thin layers.

9. An actuator as claimed in claim 8 wherein electroactive polymer includes a thin layer of one of a conducting particulate and a conducting flake and the next adjacent layer is one of a low hardness RTV silicone and low hardness elastomer.

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10. An actuator as claimed in claim 2 further including a means for obtaining electrical energy from the transducer responsive to a mechanical load and an electrical load applied thereto whereby the transducer acts as an electrical generator.

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11. An actuator as claimed in claim 3 wherein each conducting layer is conducting material chosen from the group consisting of gel, powder, grease, polymer, composite and patterned metal and a combination thereof.
- 5 12. An actuator as claimed in claim 3 wherein each conducting layer includes a plurality of layers.
13. An actuator as claimed in claim 12 wherein at least one conducting layer includes a cross-linked elastomeric layer.
- 10 14. An actuator as claimed in claim 12 wherein at least one conducting layer includes a patterned layer.
- 15 15. An actuator as claimed in claim 12 wherein at least one conducting layer includes at least one distinct patterned region.
16. An actuator as claimed in claim 12 wherein at least one conducting layer includes a plurality of distinct patterned regions.
- 20 17. An actuator as claimed in claim 12 wherein the thickness of each of the plurality of conducting layer ranges from 0.05um to 100nm.
18. An actuator as claimed in claim 3 further including a shielding layer.

19. An actuator as claimed in claim 18 wherein the shielding layer is one of low insulating low durometer elastomer, polydimethylsiloxane microcellular foam, and conducting RTV silicone.

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20. An actuator as claimed in claim 18 wherein the shielding layer is polydimethylsiloxane micocellular form having a thickness from 0.1 mm to 1 mm.

10 21. An actuator as claimed in claim 18 wherein the active region further includes a general purpose layer.

22. An actuator as claimed in claim 21 wherein the active region is arranged such that there is a first conducting layer, a first electroactive polymer layer, a second
15 conducting layer, a general purpose layer, a third conducting layer, a second electroactive polymer layer and a fourth conducting layer.

23. An actuator as claimed in claim 22 wherein the general purpose layer is one of an anisotropy composite material, and a thin stiff polymer.

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24. An actuator as claimed in claim 22 wherein the general purpose layer includes oriented insulating fibers in a circumferential direction suspended in a soft matrix.

25. An actuator as claimed in claim 22 wherein the general purpose layer has monitorable electrical properties.
- 5 26. An actuator as claimed in claim 22 wherein the general purpose layer is one of a thin stiff polymer and a ceramic composed of one of a polypropylene and mica.
- 10 27. An actuator as claimed in claim 22 wherein the general purpose layer is a thin dielectric media capable of energy storage.
28. An actuator as claimed in claim 22 wherein the general purpose layer includes a flexible printed circuit board.
- 15 29. An actuator as claimed in claim 18 wherein the mechanical connectors are made of a stiff insulating material.
30. An actuator as claimed in claim 29 wherein the stiff insulating material has a conductive coating.
- 20 31. An actuator as claimed in claim 29 wherein the stiff insulating material is conductive material.

32. An actuator as claimed in claim 3 wherein the transducer is hollow.

33. An actuator as claimed in claim 32 wherein a check valve is positioned in the hollow of the actuator.

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34. An actuator as claimed in claim 3 wherein one of the pair of mechanical connectors is integrally attached to the positive connector and the other of the pair of mechanical connectors is integrally attached to the negative connector.

10 35. An actuator as claimed in claim 18 further including a structural core.

36. An actuator as claimed in claim 35 wherein the structural core includes one of a spring, a tube, a plurality of rings and a plurality of discs.

15 37. A method of manufacturing a stretched rolled electroactive polymer actuator comprising the steps of:

stretching and holding an electroactive polymer layer;

adhering conductive layers to the stretched polymer layer to form an active region;

20 attaching electrical contacts to the active region;

attaching structural supports to the active region; and

rolling the active region.

38. A method as claimed in claim 37 further including the step of electrode patterning on the conductive layers.
39. A method as claimed in claim 37 wherein the electroactive polymer layer has a thickness ranging from 0.05um to 1mm.
40. A method as claimed in claim 39 wherein the electroactive polymer is elastomeric material having a modulus ranging from 10 KPa to 100 MPa.
41. A method as claimed in claim 40 wherein the electroactive polymer is elastomeric material having hardness properties ranging from 10 to 60.
42. A method as claimed in claim 37 wherein stretching and rolling of the electroactive polymers results in improved strain capability of the actuator.
43. A method as claimed in claim 37 wherein the electroactive polymer is prestretched independently in each direction by an amount ranging from 90% to 800%.
44. A method as claimed in claim 37 wherein the prestretch is imposed by mechanical means.
45. A method as claimed in claim wherein 37 the prestretch is imposed during

polymerization by application of organized stress of one of an electric field and a magnetic field and a combination thereof.

46. A method as claimed in claim 37 wherein the electrode is a conductive layer comprising one of powder, grease, particulate filled polymer, patterned metal, cement and conductive polymers and a combination thereof.

47. A method as claimed in claim 37 wherein the conducting layer is a plurality of layers each having a thickness ranging from 0.05um to 100um.

48. A method as claimed in claim 37 wherein the electrical contacts are one of metallic shims, flexible conducting polymers and conductive grease and a combination thereof.

49. A method as claimed in claim 48 wherein the electrical contacts provide both mechanical and electrical connections.

50. A method as claimed in claim 48 wherein the metallic contacts are patterned to optimize power flow to the actuator.

51. A method as claimed in claim 37 wherein the electroactive polymer includes a plurality of layers.

52. A method as claimed in claim 37 further including the step of attaching a packaging layer wherein the packaging layer shields and isolates the electroactive polymers from a surrounding environment and electronics.